



# Backgrounder

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## Boeing's Approach to Flight Test Ensures Safety

Flight test is one of the final phases of verification of the operational characteristics and overall performance of a new airplane. Like laboratory testing, flight testing is a means of demonstrating that the design intention is being fulfilled by the airplane.

The data collected during flight test is part of the information required by the Federal Aviation Administration (FAA) and other regulatory agencies to certify that a new airplane meets all Federal Aviation Requirements (FARs) and is ready to enter revenue service with airlines around the world.

Each flight test airplane is outfitted with an array of sensors and monitoring devices to gather the data required to document the airplane's response to testing conditions. The passenger cabin of most flight test airplanes is outfitted with monitoring stations and computers. Ballast, in the form of barrels of water, is added to the airplane to simulate in-service loading conditions and giving the crew the ability to induce different centers of gravity (forward, center and aft) to validate performance at a variety of settings.

In the Boeing approach to flight test, there are three high-level milestones that mark progress: initial airworthiness; Type Inspection Authority; and function and reliability testing, which includes demonstration of extended twinjet operations (ETOPS) capabilities. The first two milestones occur early in the test program with the final milestone initiating the bulk of the testing.

Initial airworthiness testing, includes first flight and the beginning of the exploration of the flight envelope. The flight envelope is the defined parameters within which the airplane may operate – from normal conditions to extreme conditions.

During initial airworthiness testing, minimal crew – only two pilots – are on board. Testing locations are limited by the range of the monitoring equipment on the ground, keeping testing within the state of Washington. Test sequences during this phase include flying at a variety of flap settings, speeds and altitudes. Extreme conditions are not part of this testing though they are tested later in the program.

After achieving initial airworthiness, additional test personnel are able to fly onboard the airplane. This enables more extensive testing as the airplane can now be operated remotely. With test personnel on board, sensor readings can be monitored on the airplane instead of being relayed to ground-based personnel.

Next, Boeing works to earn its Type Inspection Authority (TIA) from the FAA. TIA is the FAA's verification that it has agreed with Boeing on the testing that needs to be performed to achieve certification and that Boeing has demonstrated the stability of the airplane. Achieving TIA clears the way for FAA personnel to participate in flight testing.

Working to achieve TIA requires further exploration of the flight envelope, most notably including flutter testing, which tests the airplane's stability and dampening modes at design limit speeds and high altitude for multiple configurations.

Once the FAA has granted TIA, functional and reliability testing begins in earnest. During this phase of testing, the extremes of the flight envelope are explored. Testing conditions include operations in hot weather and cold weather as well as takeoffs and landings at high altitude airports. In addition, over-speed conditions, hard landings and engine-out conditions are tested.

At the end of the flight test program, Boeing and the FAA have developed a full understanding of the airplane in both normal and non-normal circumstances. The flight test pilots purposefully put the airplane through maneuvers that most pilots will never see during their careers. This is how they ensure the airplane can be safely operated in revenue service.

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